ATV, which is continuously operated during traverses mapping the route in real time using a Global Positioning System (GPS). This system gives the explorers their location and a topographic map of the local area at all times. Additionally, video cameras allow people at base camp to view the terrain seen by the exploration party. Text or audio communications between the mobile node and base camp are also supported. Pen-based graphical tablets can be used to control the applications resident on the server, providing a human/computer interface usable in both rain and bright sun. Experiments in voice recognition and other user interface modalities are ongoing.

The primary goals for the FY99 field season were to test satellite communications, base-camp computational infrastructure, and the performance and deployment of the CAN radio systems. These goals were fully met, and resulted in certain design improvements.

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Development of the Vapor Phase Catalytic Ammonia Removal Process

Michael Flynn, Bruce Borchers

Ames Research Center (ARC) has recently completed the development and testing of a prototype Vapor Phase Catalytic Ammonia Removal (VPCAR) system that represents the next generation in spaceflight water recovery systems. Water is the single largest resupply requirement associated with human spaceflight, accounting for 87% by mass of an astronaut's daily metabolic requirement. The VPCAR system achieves a mass metric almost an order of magnitude better than the current state-of-the-art water processors. (Mass metric is a technique used to reduce all performance parameters into launch mass.) Incorporating the VPCAR technology into human spaceflight missions could potentially save hundreds of millions of dollars in resupply costs, depending on the specific mission scenario. As a result, a human-rated version of the VPCAR technology has been authorized for development, and when completed it will be used for human testing in a closed chamber.

The VPCAR process is a two-step distillation-based water processor. The current configuration of the technology is shown in figure 1. The VPCAR process is characterized by the use of a wiped-film rotating-disk vacuum evaporator to volatilize water, small molecular weight organics, and ammonia. This vapor stream is then oxidized in a vapor phase catalytic reactor to destroy any contaminants. The VPCAR process uses two catalytic beds to oxidize contaminants and decompose any nitrous oxide (N_2O) produced in the first bed. The first catalytic bed oxidizes organics to carbon dioxide (CO_2) and water, and ammonia to N_2O and water. This oxidation reactor contains 1% platinum on alumina pellets and operates at about 523 kelvin (K). The second catalytic bed reduces the N_2O to nitrogen and oxygen. This reduction catalyst contains 0.5% ruthenium on alumina pellets and operates at about 723 K. The reactor and distillation functions occur in a single modular process step, no scheduled maintenance is required, and the system has no resupply requirements. The process achieves between 97 and 98% water recovery.

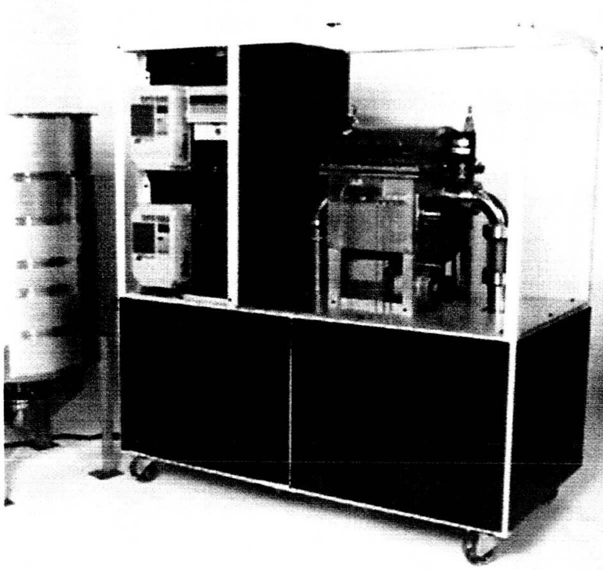

Fig. 1. Vapor Phase Catalytic Ammonia Removal (VPCAR) water recycling system.

The VPCAR activity is significant because it represents the development of the next generation of life support water recovery technology. It also shows how the research and development capabilities of one NASA center can be integrated into the operational requirements of another NASA center to reduce the cost of human spaceflight programs. Ames has been involved from the first principle definition to the model development, bench-scale and lab-scale prototype development, and contract management of the development of a human-rated version of the technology for transfer to a NASA spaceflight center. Johnson Space Center will develop the final spaceflight version.

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Human-Centered Computing Studies on the NASA Haughton-Mars Project

William J. Clancey, Maarten Sierhuis, Pascal Lee

During the past two field seasons, July 1998 and 1999, Ames researchers investigated the field practices of scientists and engineers at Haughton Crater on Devon Island in the Canadian Arctic, 500 miles north of the Arctic Circle, under the auspices of the NASA Haughton-Mars Project (HMP). On the HMP, human-centered computing (HCC) studies (part of Exploration Research) are aimed at determining how human explorers might live and work on other planetary objects, in particular on Mars.

This broad HCC investigation of field life and work practice spans social and cognitive anthropology, psychology, and computer science. The investigation involved systematic observation and description of work activities, locations, and learning in the field, constituting an ethnography of field science at Haughton. The focus was on human behaviors—what people do, where, when, with whom, and why. By locating behavior in time and place—in contrast to a purely functional or "task-oriented" description of work—the group identified patterns constituting the choreography of interaction between people, their habitat, and their tools.

To develop requirements for new kinds of tools for living and working on Mars, the group focused on the existing representational tools (such as documents and measuring devices), learning and improvisation (such as use of the Internet or informal assistance), and prototype computational systems brought to the field.

In addition to observing by participating in the expedition, human-centered computing scientists took extensive photographs and videos, which were analyzed for patterns. For example, to understand the relation between how technologies were used in different work and living spaces, a video camera was placed between the shared work tent, the natural sciences tent, and the large dome tent, with a view of the all-terrain vehicles (ATV) parked on the terrace in front (figure 1). During a three-hour period, quarter-size video frames (320 x 240 pixels) were directly captured to computer disk every 3 seconds (a compromise between storage and visible information). This video therefore logged occupation and motion between four key areas of the base camp, as well as capturing use of some personal tents. The layout was of special interest because motion between the work and dome tents might correspond to the upper and lower decks in a Mars habitat.

The resulting video was coded on a spreadsheet. Durations of visits and number of people occupying each area were calculated in Excel. Averages and

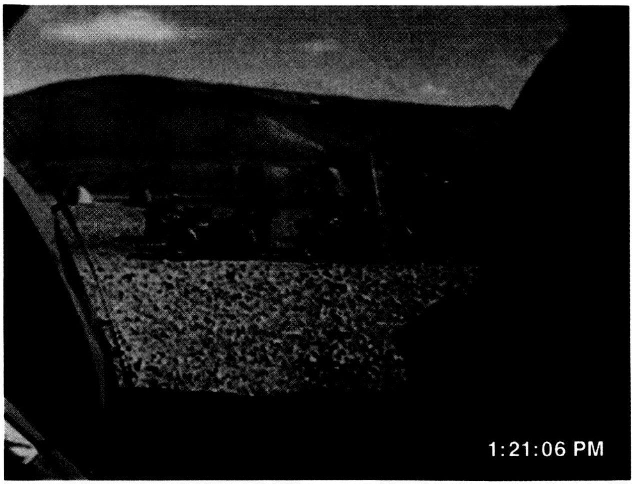

Fig. 1. Example frame, showing an exit event from work tent and (at least) two people at the ATV staging area.